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Digital and Analogue interactions: Process Chain Networks for the Design of Service Processes

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Abstract— **Designing for customer resources in service processes can impact efficiency, economies of scale, control and customization. There are analogue or digital process steps, digital will be embedded into devices or software. Knowing when to use analogue and digital is a service design choice. Process Chain Network diagrams can aid decision making and help design for service interactions and user acceptance. Case examples using the methodology illustrate the design and theoretical approach. These case examples show service process design is a strategic and competitive mechanism for service organizations.**

Keywords; **Service Design; Service Processes; Unified Service Theory; Process Chain Network.**

I. Introduction

There are many opportunities created for embedded cyber-physical systems by the combination of products, human interactions and networks [1]. Cyber physical systems integrate computational and physical resources into embedded computers and networks that control physical and computational processes [2]. The opportunities and embedded designs and controls are well documented within the embedded computer and Internet of Things literature [3]. Efficiency in this context is often discussed in terms of efficient use of memory, data processing and energy consumption. Assumptions are often made about the overall efficiency of the cyber physical system because it is difficult to model and design in efficiency of the full cyber physical system as this often depends on use, skills and capabilities of humans.

Service processes and service organizations require service designs that integrate humans and physical interactions that are equally efficient, customized and create economies of scale to provide commercially viable and competitive services. Within management and service design literature there are theoretical and conceptual frameworks and design methodologies that can support the design of embedded computing and software. These include the Unified Services Theory (UST) [4, 5], a conceptual model for defining services and customer resources and inputs. Involving customers in service processes was theoretically seen as reducing efficiency [6, 7], a view now being challenged with embedded cyber physical systems, Internet and mobile enabled processes. A further productivity-based conceptualization of the service process [8] links customer and service provider inputs to external efficiency and revenue. Service process design is also modelled from the perspective of relative throughput time and variation to illustrate impacts on productivity [9]. These, often conflicting design principles, can be mitigated by methodology [10], a Process Chain Network (PCN), for integrating service design, connecting entities, human interaction, control and design principles for service processes. This can provide a practical mechanism for service design.

Firstly, this paper first defines services and the customer resources available using the UST. Secondly, the service process is illustrated on a PCN, highlighting how process steps in direct and surrogate interaction have impacts on customization, control, efficiency and economies of scale. Finally, two service processes are analyzed and presented using a PCN analysis. These cases illustrate the use of the design framework for mobile money and higher education using Unified Service Theory.

II. Services and the Unified Services Theory

Despite services representing 70-80% of Gross Domestic Product (GDP), defining services, service systems, service processes and service design within academic literature and practice is fraught with contradictions. Contingency and contextual dependencies are often cited as a rationale for many alternative views. The UST [5] provides defining characteristics of services that propose a universal theoretical frame for service design. These characteristics within the UST are as follows:

- The customer provides significant inputs into the production process.
- There are three general types of customer inputs into service processes: the customer's self, belongings, and/or the customer's information.
- The service ‘production’ process is defined as company effort to add value to customer inputs.

- Service production (making the service "product") and consumption (customer demand or delivery) often occurs simultaneously, making the exact timing of production a critical issue
- With services, different process segments have different degrees of customer input, and some may have none (acting as manufacturing).

Using these characteristics suggest a definition of services as: “Services are production processes that act on or with customer resources” [5]. The customer inputs are needed to produce service process outcomes that add value for the customer. These inputs co-produce [11] the service and are contingent on service design and the use, skills and capabilities of customers. There are service design choices between digital and analogue inputs from customers. The choices will impact service process outcomes, the efficiency and customer value potential created.

III. SERVICE PROCESSES AND PROCESS CHAIN NETWORK DIAGRAMS

A service system consists of person-to-person encounters, technology mediated interactions, multichannel, multi-device, and physical location-based systems. Some of these systems can be information intensive or people interactive service processes [12]. Service systems consist of service processes and customer inputs to co-produce outcomes.

Customer inputs can be direct, surrogate or independent as defined within the UST and PCN Methodology.

a) *Direct Interaction*, Entity/person acting in conjunction with another entity/person.
b) *Surrogate Interaction*. Entity/person acting on/with resource(s) of another entity. People with things (belongings, information).
c) *Independent Processing*. Entity or person acting only on/with entity’s own resources.

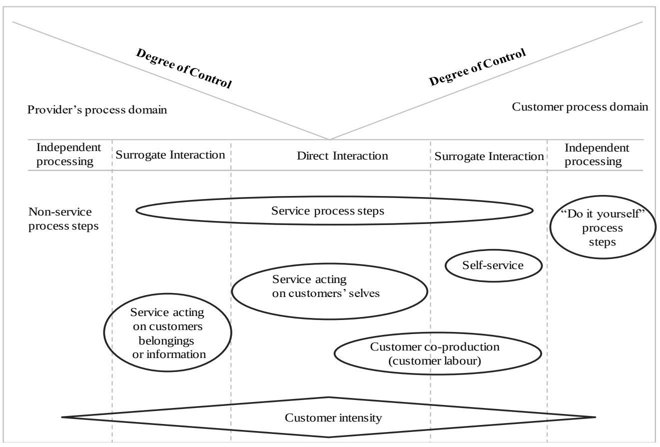

Figure 1. UST process regions characteristics [10]

These customer inputs and those of the provider are illustrated on a PCN diagram with customer interaction and input regions shown in Figure 1.

These regions of customer input processing have different characteristics. Process steps can be mapped across these regions for the overall process to create a service design and analysis framework. Cyber physical systems often span all regions for the provider and customer. A common configuration for systems requiring digital inputs is often customer surrogate interaction with independent processing in the provider’s domain. The process design characteristics and choice of region are likely to have an impact on performance outcomes of the service process.

The service process designs for receiving customer inputs are consequently a strategic choice when designing embedded cyber physical systems. These are increasingly designed for surrogate interaction and independent processing. This leads to a question; is the choice of interactive region for service processes related to the outcomes desired by the provider? The potential performance outcomes of the design choices are explored in mobile money and higher education cases.

IV. MOBILE MONEY CASE

A United Kingdom (UK) based challenger bank, a startup in 2014, now has over 1 million customers. It is the first bank to launch app based current, joint, and business account. The Chief Executives Officer’s idea was to remove jargon, fees and clunky technology and produce a new kind of bank that gave customers the digital tools they needed to manage their money. The service process of opening an account is based on an app using a smartphone. Figure 2 illustrates the account opening process on a smart phone.

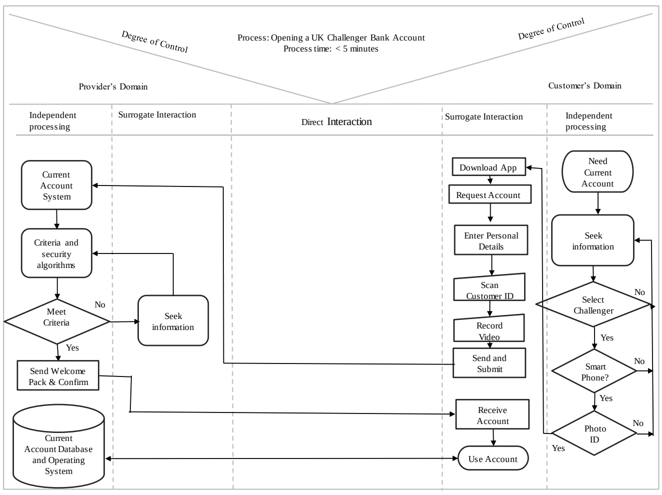

Figure 2. PCN for account opening, UK challenger bank

This PCN for opening an account illustrates that the bank has chosen independent processing and surrogate interaction in the customer domain for the account opening process. There is no need for direct interaction by telephone, branch visits or inbound mail. These design and region choices for customer input mean the bank has achieved economies of scale (independent processing), increased its control of the process and reduced the inefficiency created by direct interaction. With the process taking less than five minutes, the account opening process in the customer domain is effective and efficient, providing more control and customization of when the customer opens the account. When contrasting this to how existing banks account opening processes work it illustrates how service process design using surrogate interaction and independent processing can offer competitive advantage in customer acquisition. This has enabled the new UK bank to grow accounts and challenge existing banks. Applying this design approach to the other bank processes such as, account switching, categorization of spending and using geolocation to supplement transaction records has further increased customer retention, intimacy and value potential.

V. HIGHER EDUCATION CASE

The previous case illustrated two regions of a PCN diagram that are commonly used in cyber physical systems. Service design can occur across all five regions. The second case is a teaching unit on an international Master's in Science (MSc) Programme. This Digital Business unit has 360 students and covers a teaching and assessment period of 16 weeks. Here the service design challenge is to achieve student learning outcomes, whilst achieving efficiency, control and encourage student engagement. Figure 3 shows the service processes used and these have been mapped onto a PCN diagram.

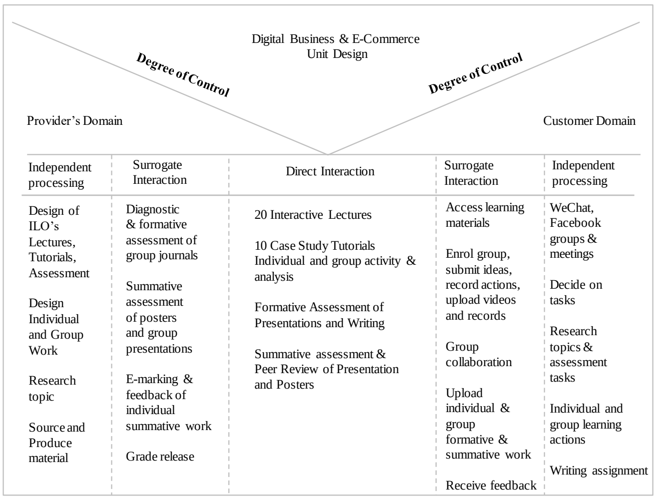

Figure 3. PCN of Digital Business Teaching Unit

In this service design the different service processes that make up the unit have been designed into all the regions of the PCN diagram. Different pedagogical outcomes require service process designs that achieve effectiveness, efficiency, and different levels of control. Customization for individual and group learning styles is also required for some of the processes. For example, group collaboration is managed by groups through the institutions Virtual Learning Environment (surrogate interaction), achieving a degree of customization and peer-to-peer learning. The assessment process, again surrogate interaction, supplements direct interaction assessment of groups, with individual work assessed using institution digital tools. These designs assist in managing trade-offs between outcomes and ensuring the overall unit provides a service experience for students, whilst achieving an efficient service delivery for the institution.

VI. SERVICE DESIGN IMPLICATIONS FOR OUTCOMES

These two case studies illustrate a potential relationship between service design in specific regions and the outcomes. These service design choices have been aimed at specific outcomes and suggested there is a relationship between direct interaction, surrogate interaction and independent processing that produces different outcomes in relation to control, customization, efficiency and economies of scale. This concurs with the UST and visualization of service operations [5, 10]. Figure 4 illustrates these relationships on a PCN diagram.

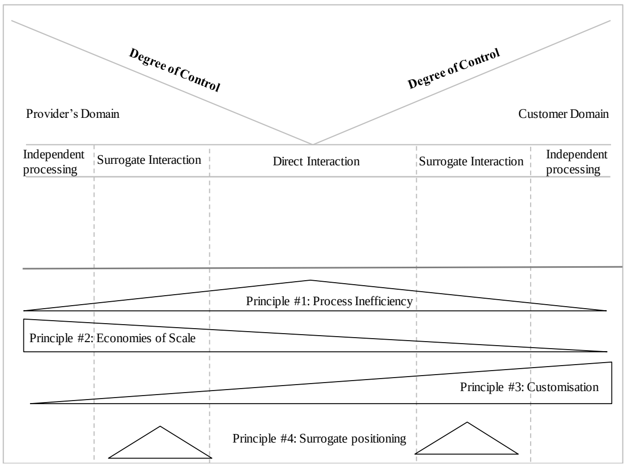

Figure 4 PCN outcome relationships, adapted from[10]

This diagram shows that a movement from direct interaction to surrogate interaction is likely to result in providing more control and reducing inefficiencies. In the customer's domain providing further customization and control. In the provider's domain a movement to surrogate interaction is likely to reduce inefficiencies, increase economies of scale and reduce the impact of customer input variation. For example, in the UK challenger bank the economies of scale were created by the application of independent processing of account opening whilst reducing inefficiencies by using a surrogate service process design in the customer's domain. In the higher education example, all regions were used for the different service processes associated with delivering a teaching unit. This enabled the institution to match service designs to the required outcomes of the various service processes.

VII. CONCLUSIONS

The application of the UST and PCN methodology illustrates the impacts of service process designs for receiving customer inputs. These frameworks and constructs can be applied to the design of embedded cyber physical systems that are created for customer interaction. The design methodology can be applied to apps, devices, wearables, the Internet of Things, Artificial Intelligence and Robotics. Successful applications of service process designs for interactions and input often demonstrate the application of these service design principles and characteristics. Further research is needed to demonstrate the validity and reliability of the outcome relationships of customization, control, efficiency and economies of scale by interaction type.

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